IDENTIFICATION AND RECOGNITION OF RICE PLANT DISEASES AND PEST USING CONVOLUTIONAL NEURAL NETWORK

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1 Introduction

- ☐ **Largest** rice disease and pest field data collection
- ☐ **1500** images in **heterogeneous background -** total **nine** classes
- ☐ **Eight** state-of-the-art CNN architectures used
- ☐ **Three training methods** for each CNN architecture
- ☐ Test accuracy of **99.53%** with fine-tuned VGG16
- ☐ **Memory efficient** handmade CNN with **two stage training**
- ☐ Mobile **app** in progress

2 Objective

- ☐ Distinguishing between **healthy** and **diseased** rice plant
- ☐ Categorizing **dead parts** of rice plant as healthy
- ☐ Detecting disease or pest class affecting **grain, stem** or **leaf**

Stemborer Pest Attacking Grain
BLB Disease Attacking Leaf
Sheath Blight Disease Attacking Stem

Figure: Consideration of Various Rice Plant Parts

3 Motivation

- ☐ About 70% of grossed crop area occupied by rice [1]
- ☐ Timely detection of rice disease essential for reducing loss
- ☐ 10-15% average yield loss because of 10 major diseases and pests of rice in Bangladesh [4]
- ☐ Not enough agriculture experts compared to requirement
- ☐ Need farmer friendly automation

4 Data Collection

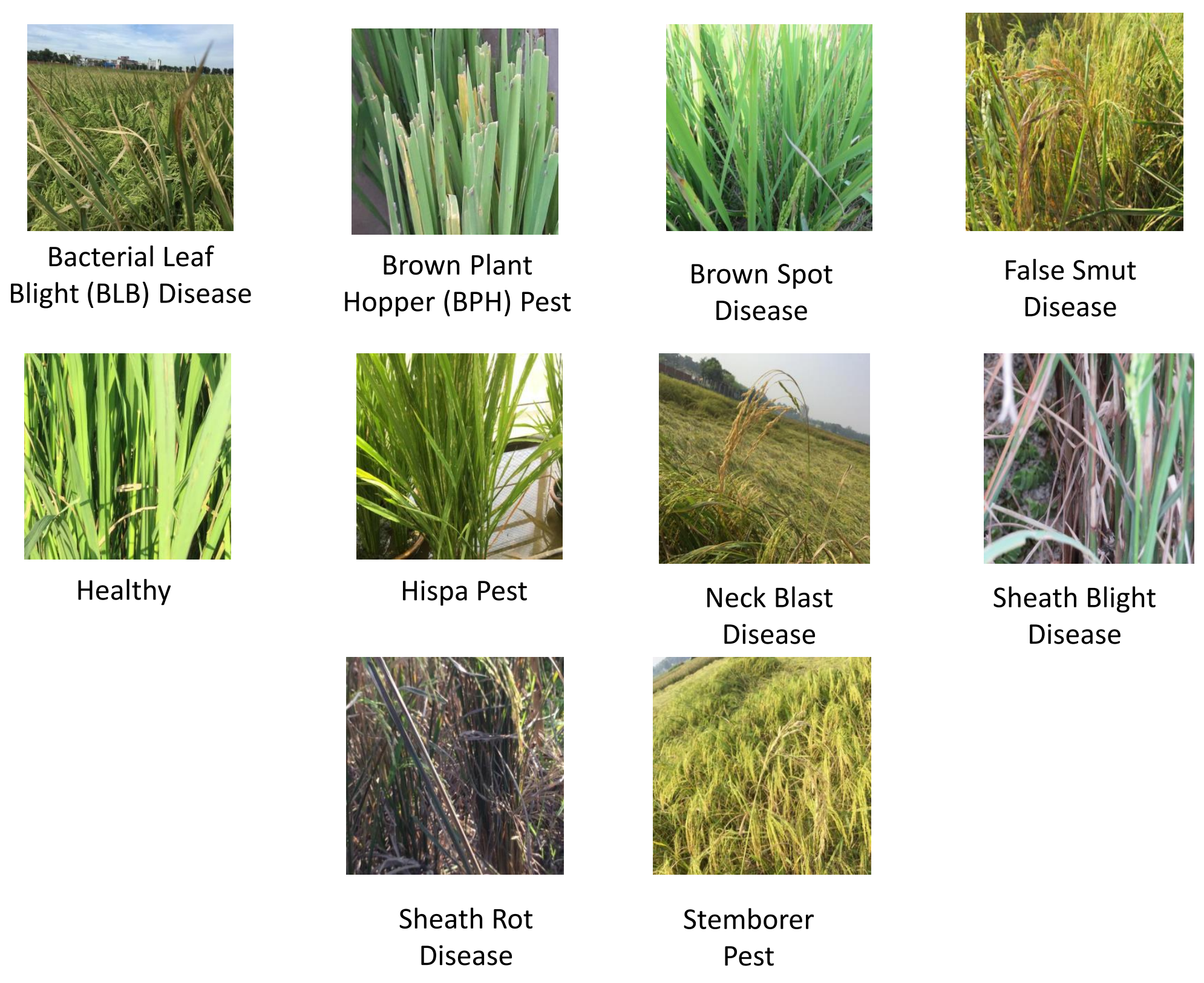

Bacterial Leaf Blight (BLB) Disease
Brown Plant Hopper (BPH) Pest
Brown Spot Disease
False Smut Disease
Healthy
Hispa Pest
Neck Blast Disease
Sheath Blight Disease
Sheath Rot Disease
Stemborer Pest

Figure: Various Classes of Disease, Pest Along with Healthy Plant Considered

- ☐ Total **nine** classes – **three** classes for **pest**, **five** classes for **disease** and **one** class for **healthy** plant
- ☐ **Sheath Blight** and **Sheath Rot** in same class because of same treatment method
- ☐ All images collected from the **field**

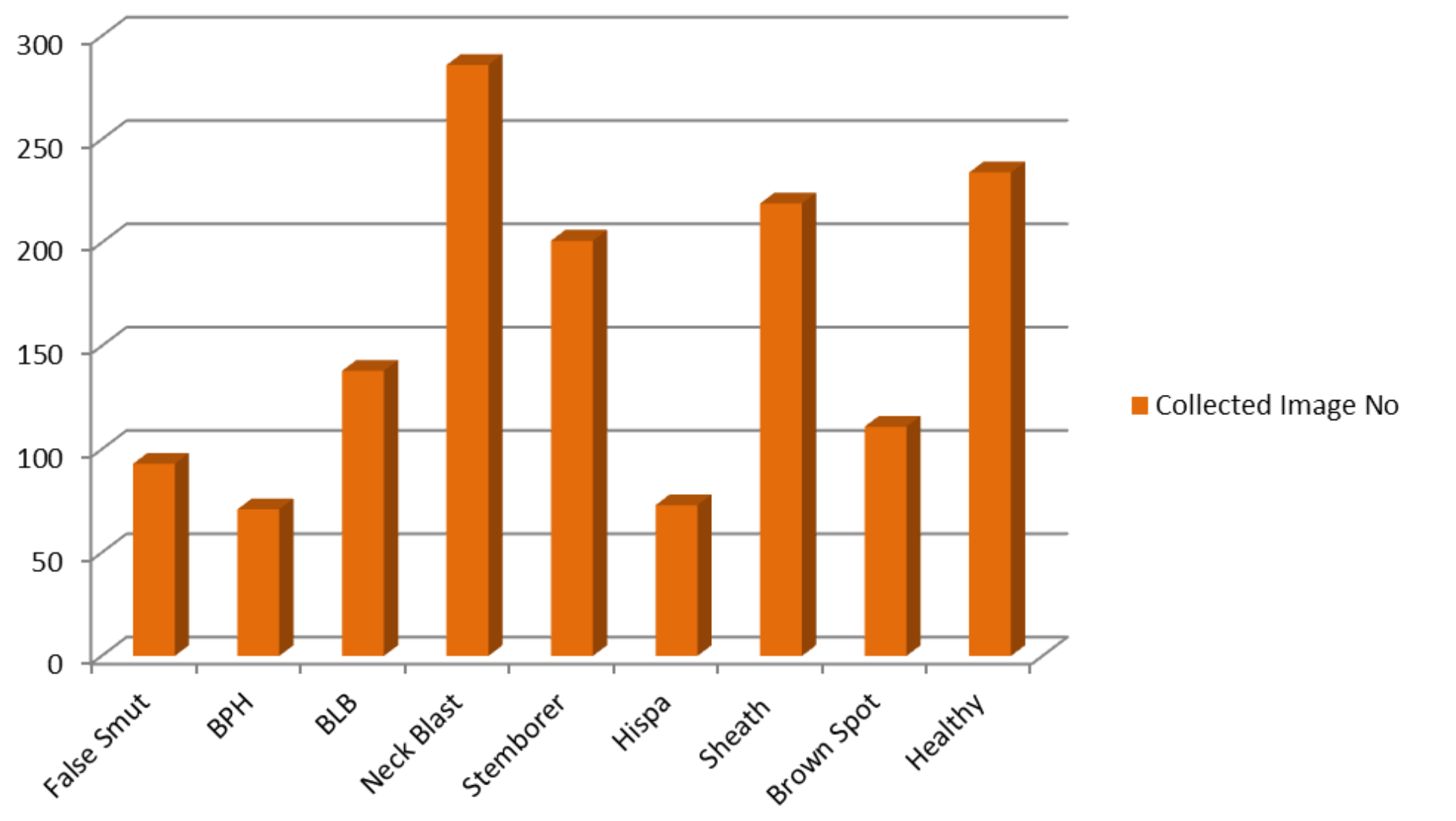
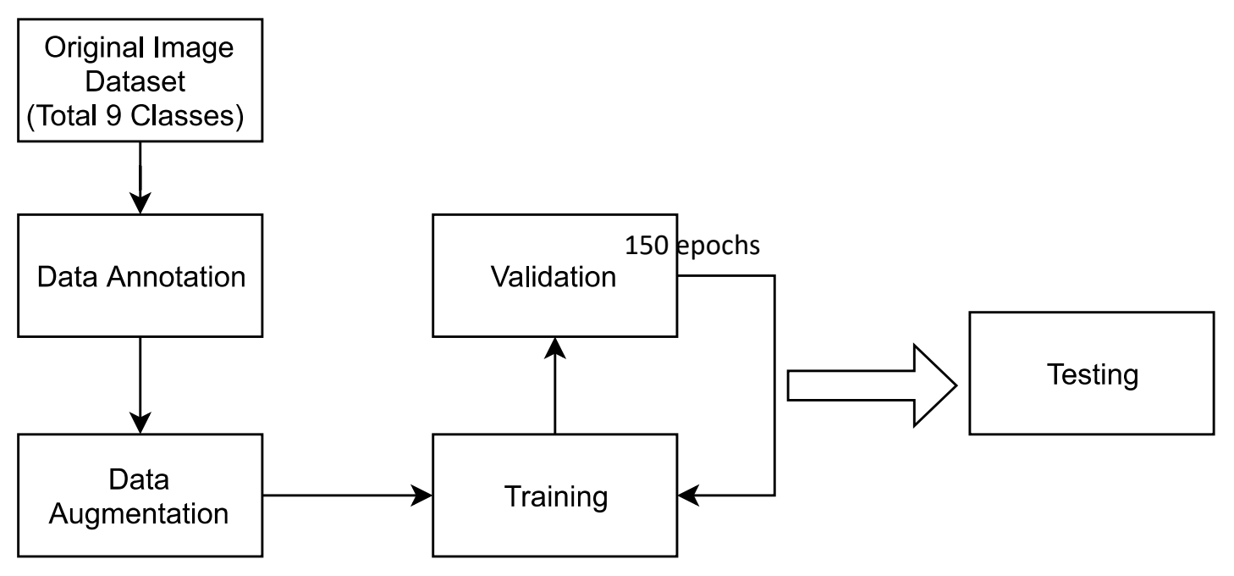


Figure: Overall Data Collection Quantity

5 Our Approach



System Overview for Large State-of-the-art CNN Architectures

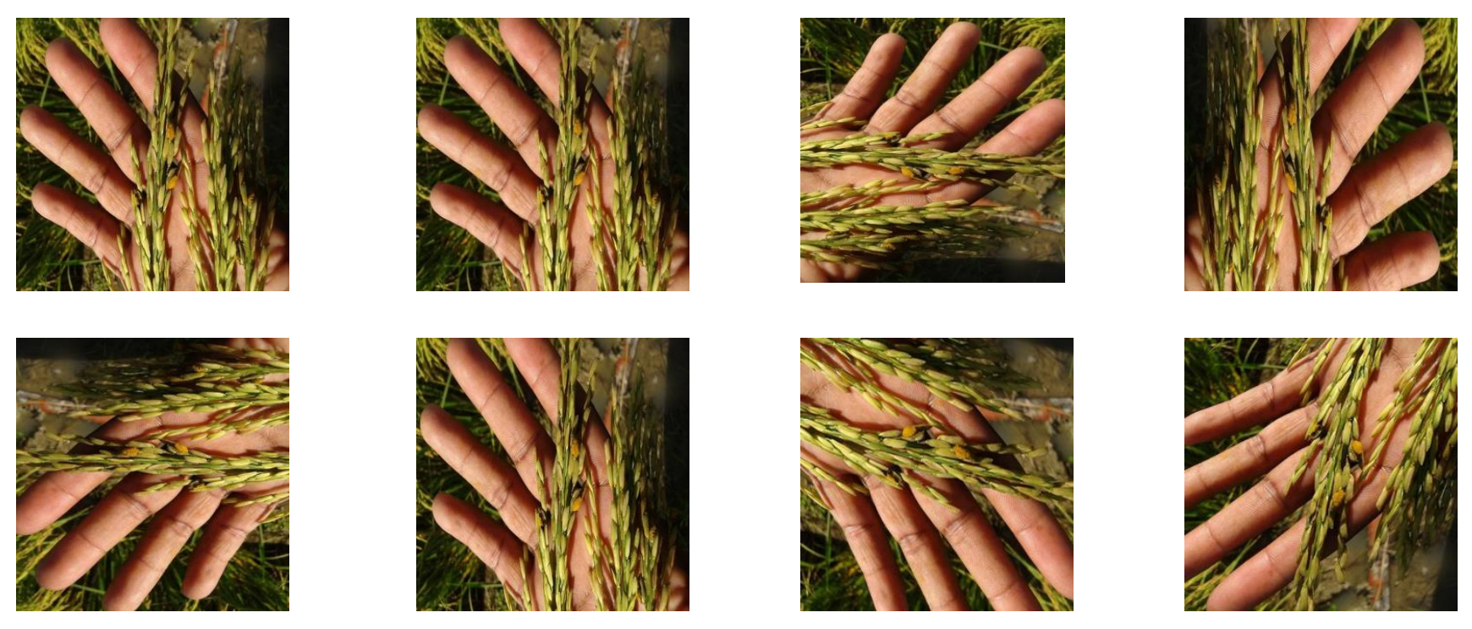
- ☐ Data splitting – 70% training, 15% validation and 15% test
- ☐ Image augmentation – 10 images from every training image

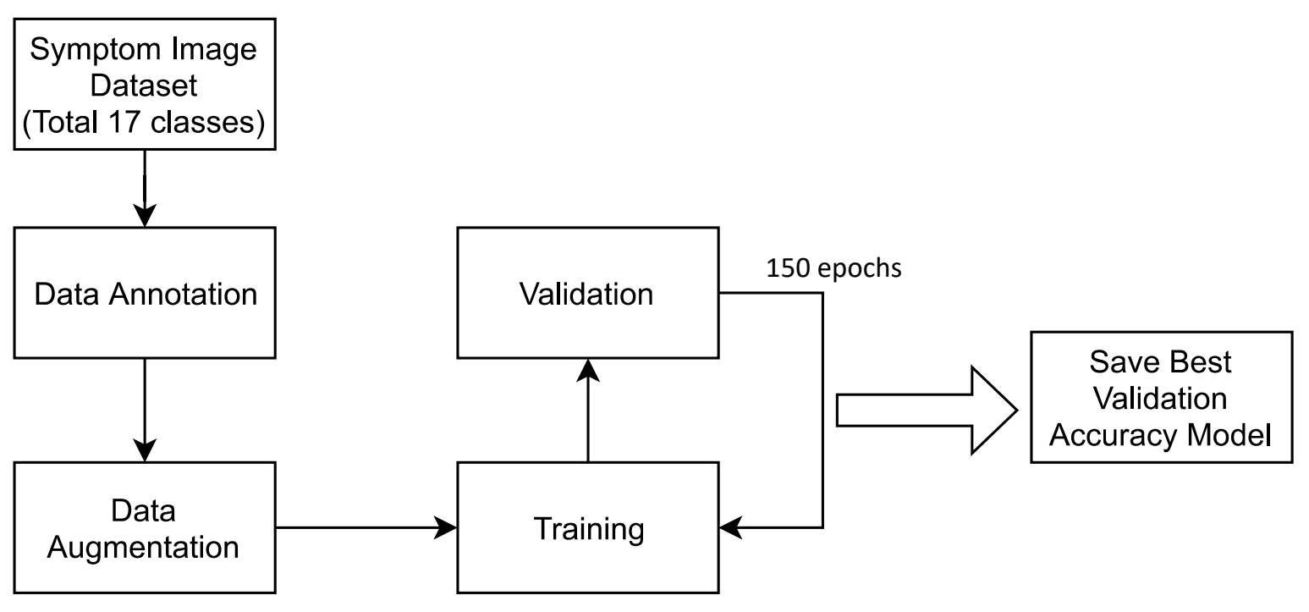
Original Training Image

Two Intensity Transformed Images

Geometric image augmentation techniques used:

- ☐ Rotation
- ☐ Random Distortion
- ☐ Zoom
- ☐ Shear Transform
- ☐ Random Flip
- ☐ Skew Transform


Variations Created by Various Combinations of Geometric Transformations


Symptom Image Dataset (Total 17 classes)
Data Annotation
Data Augmentation
Training
Validation
150 epochs
Save Best Validation Accuracy Model

First Stage Training of Small Hand-made CNN Architectures

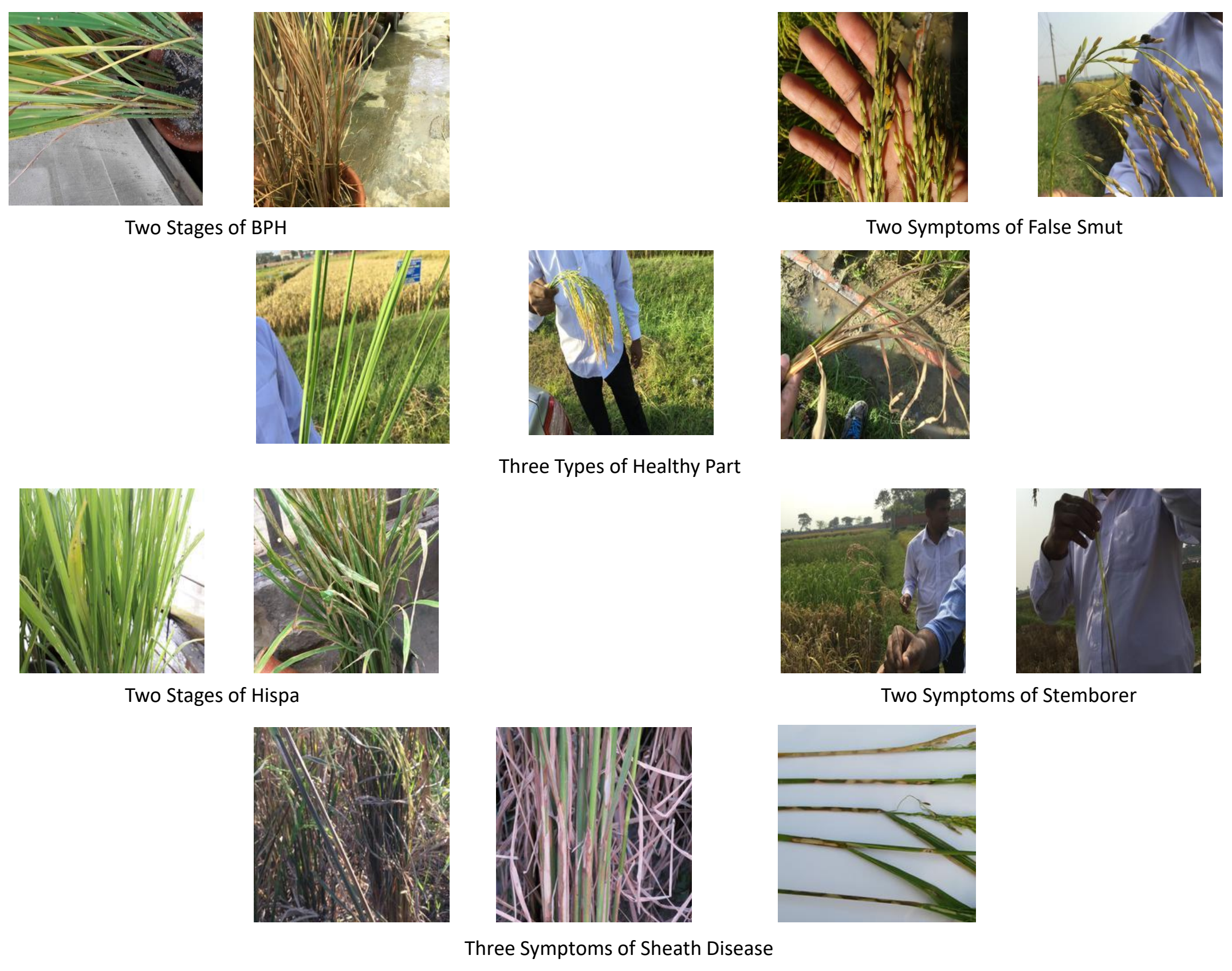

Two Stages of BPH
Two Symptoms of False Smut
Three Types of Healthy Part
Two Stages of Hispa
Two Symptoms of Stemborer
Three Symptoms of Sheath Disease

Figure: Multiple Symptom Showing Diseases and Pests

- ☐ Total 17 symptoms of nine original classes in first stage training
- ☐ No multiple symptom for BLB, Brown Spot and Neck Blast class

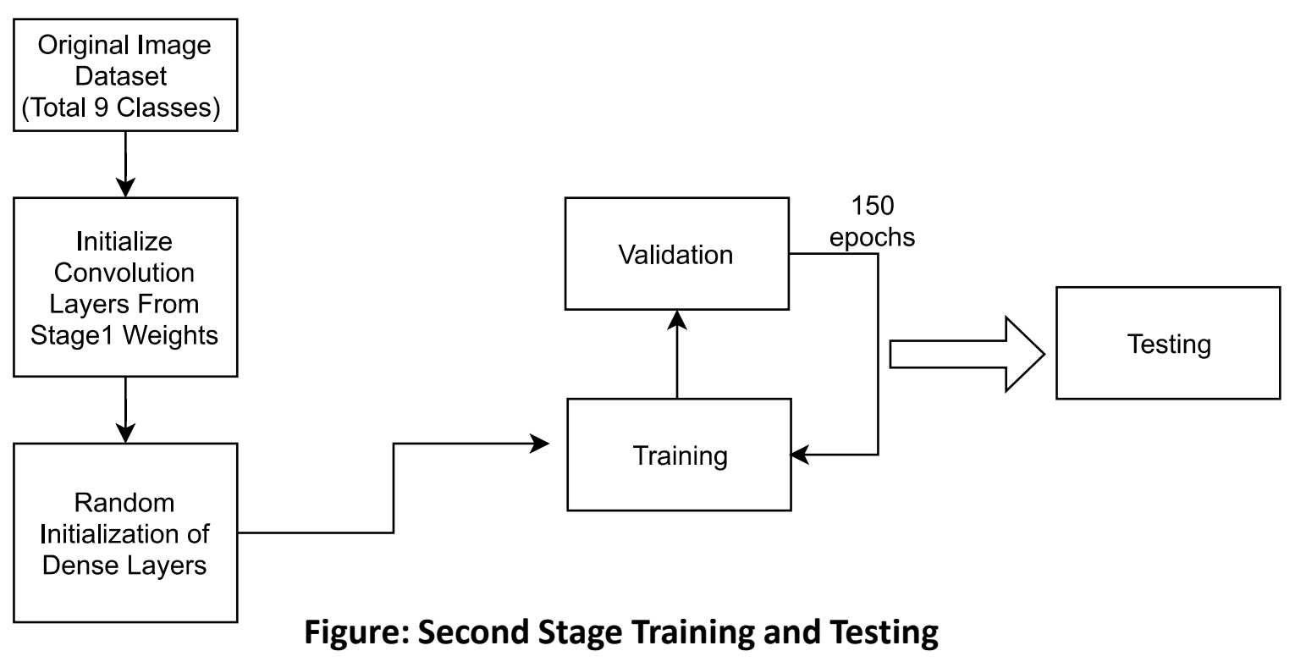

Original Image Dataset (Total 9 Classes)
Initialize Convolution Layers From Stage1 Weights
Random Initialization of Dense Layers
Training
Validation
150 epochs
Testing

Figure: Second Stage Training and Testing of Small Handmade CNN Architectures

6 Experiment

Total **eight** state-of-the-art CNN architectures (each over **200 MB** size):

1. **VGG16**
2. **ResNet50**
3. **InceptionV3**
4. **InceptionResNetV2**
5. **Xception**
6. **DenseNet121**
7. **DenseNet201**
8. **DenseNet169**

Three training methods implemented for each architecture:

- ☐ **Baseline Training**
- ☐ **Fine Tuning**
- ☐ **Transfer Learning**

Training small handmade sequential CNN architecture in **two stages**. Two sizes:

- **25 MB** model
- **10 MB** model

7 Results and Findings

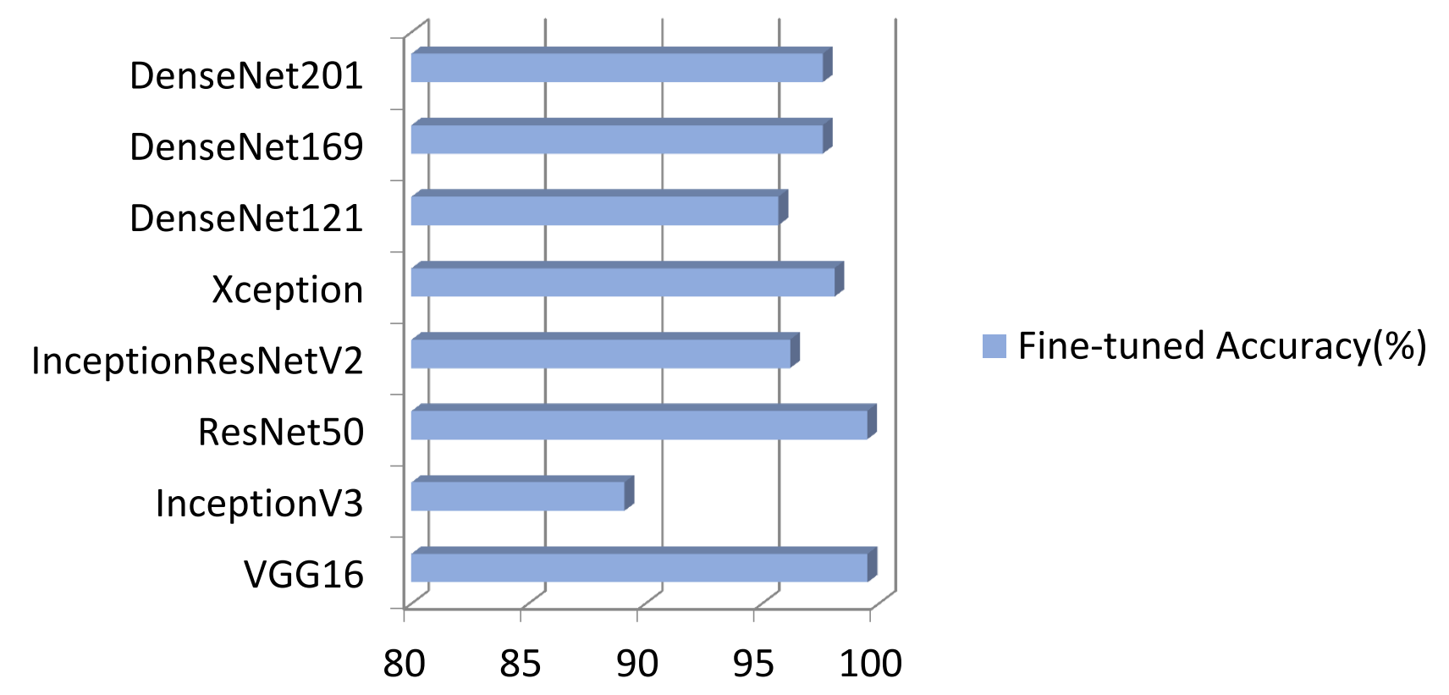


Figure: Test Classification Accuracy Comparison of State-of-the-art CNN Architectures

- ☐ **Fine-tuned VGG16** giving best test accuracy of **99.53%**
- ☐ Overall good performance of all state-of-the-art architectures except for **InceptionV3**

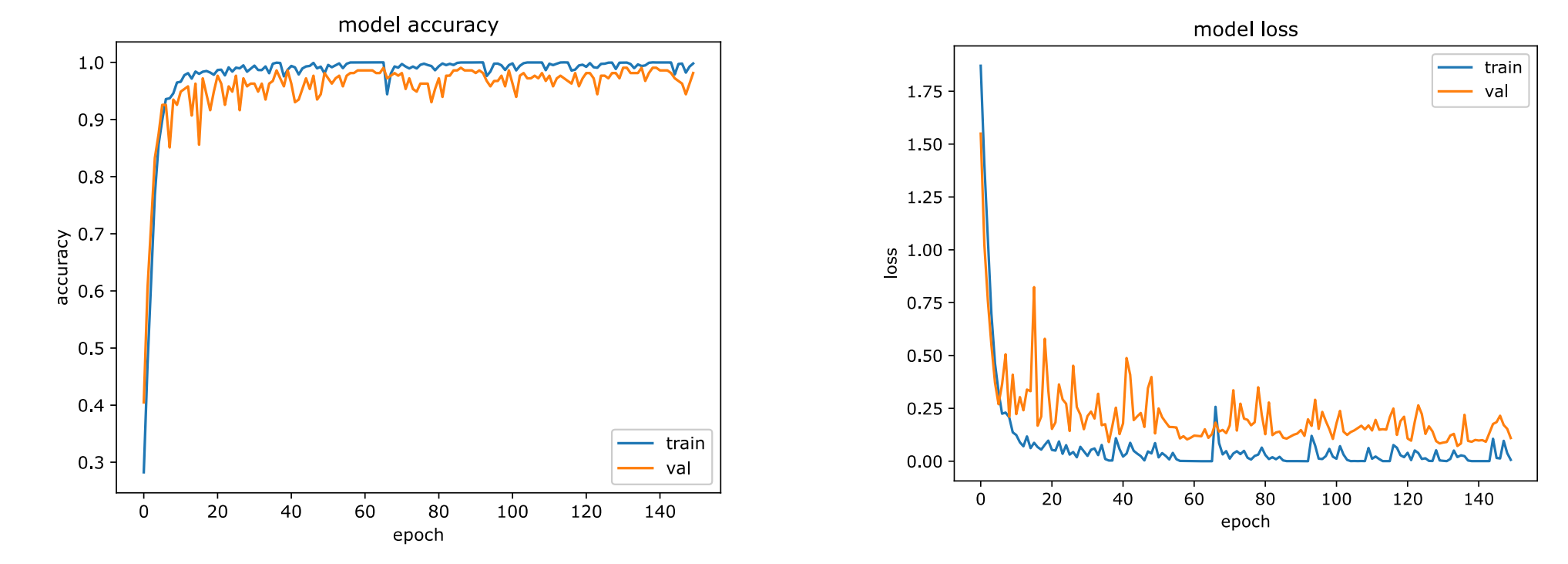


Figure: VGG16 Performance Graph

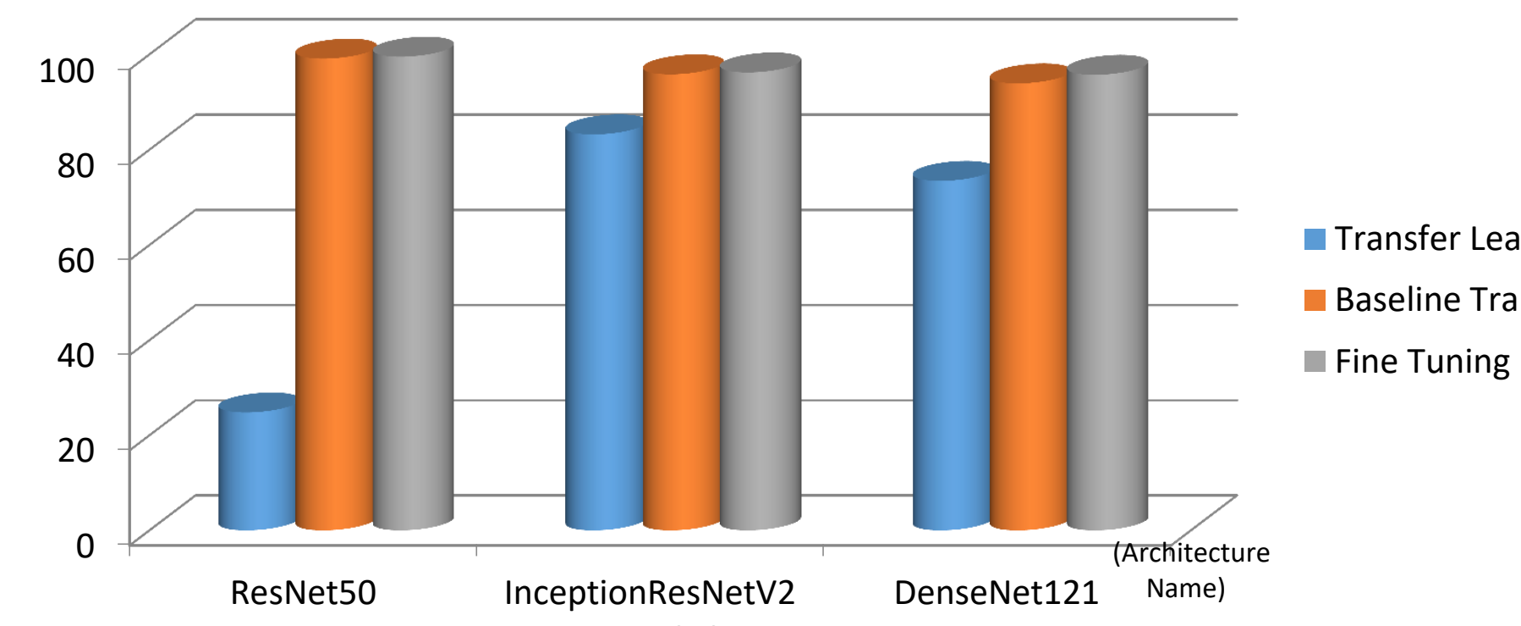
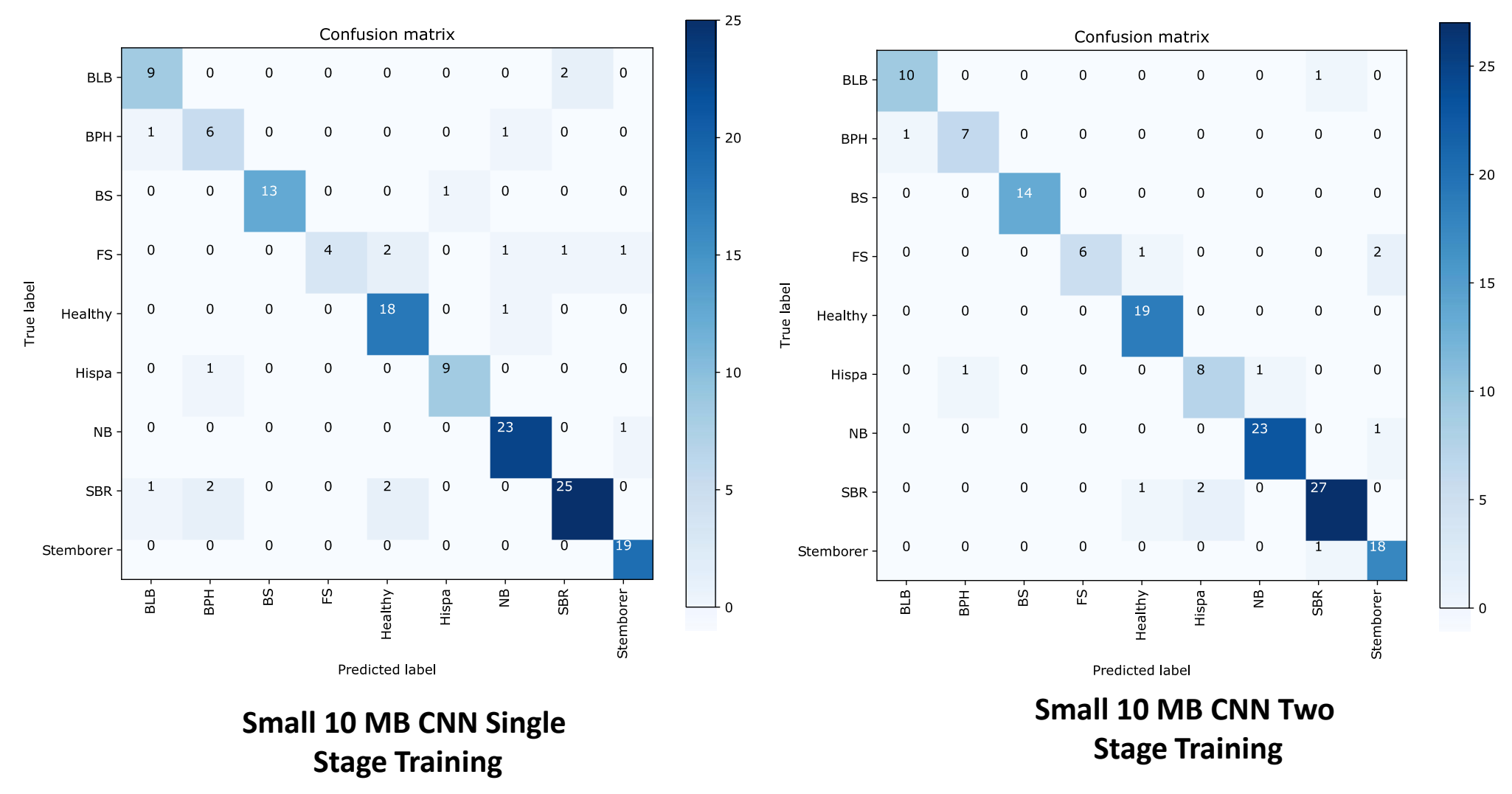


Figure: Test Accuracy(%) Comparison of Three Different Training Methods

- ☐ **Fine tuning** always giving the **best** test accuracy
- ☐ **Baseline training** accuracy **comparable** to fine tuning
- ☐ **Transfer learning** not doing so well



Small 10 MB CNN Single Stage Training
Small 10 MB CNN Two Stage Training

Figure: Confusion Matrix on Test Data

- ☐ **Non-diagonal** elements denoting misclassified test examples
- ☐ **Two stage** training giving test accuracy of **91.97%** in **10 MB** model
- ☐ **Single stage** training giving test accuracy of **87%** in **10 MB** model
- ☐ For **25 MB** model: **95%** and **87%** test accuracy for **single** and **two** stage respectively

Reference

[1] T. Coelli, S. Rahman, C. Thirtle, Technical, allocative, cost and scale efficiencies in bangladesh rice cultivation: A non-parametric approach, Journal of Agricultural Economics 53 (3) (2002) 607-626.
[2] Some appropriate technologies of rice cultivation (bengali bulletin)

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